# The Italian VLBI network and the validation of SRT: first tests and perspectives

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# Italian baselines

- Mc - Nt - Mt baselines for Geodetic experiments
- Mc - Nt - SRT baselines for Astronomical experiments
- Shortest baseline 500 km
- Longest baseline 900 km

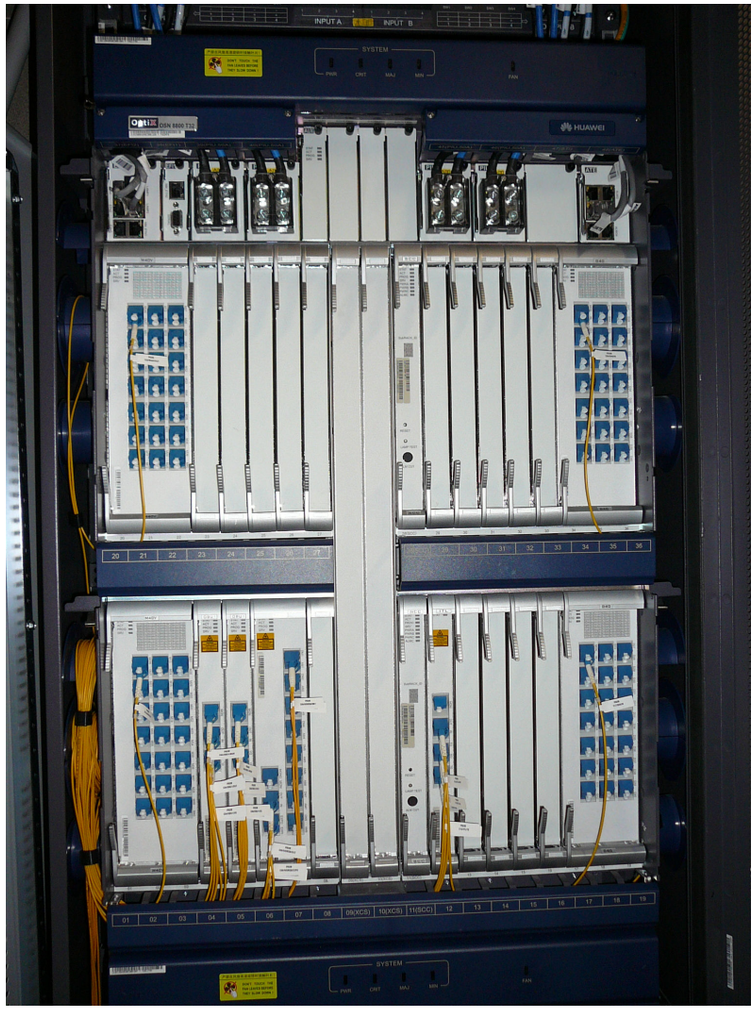
# SRT

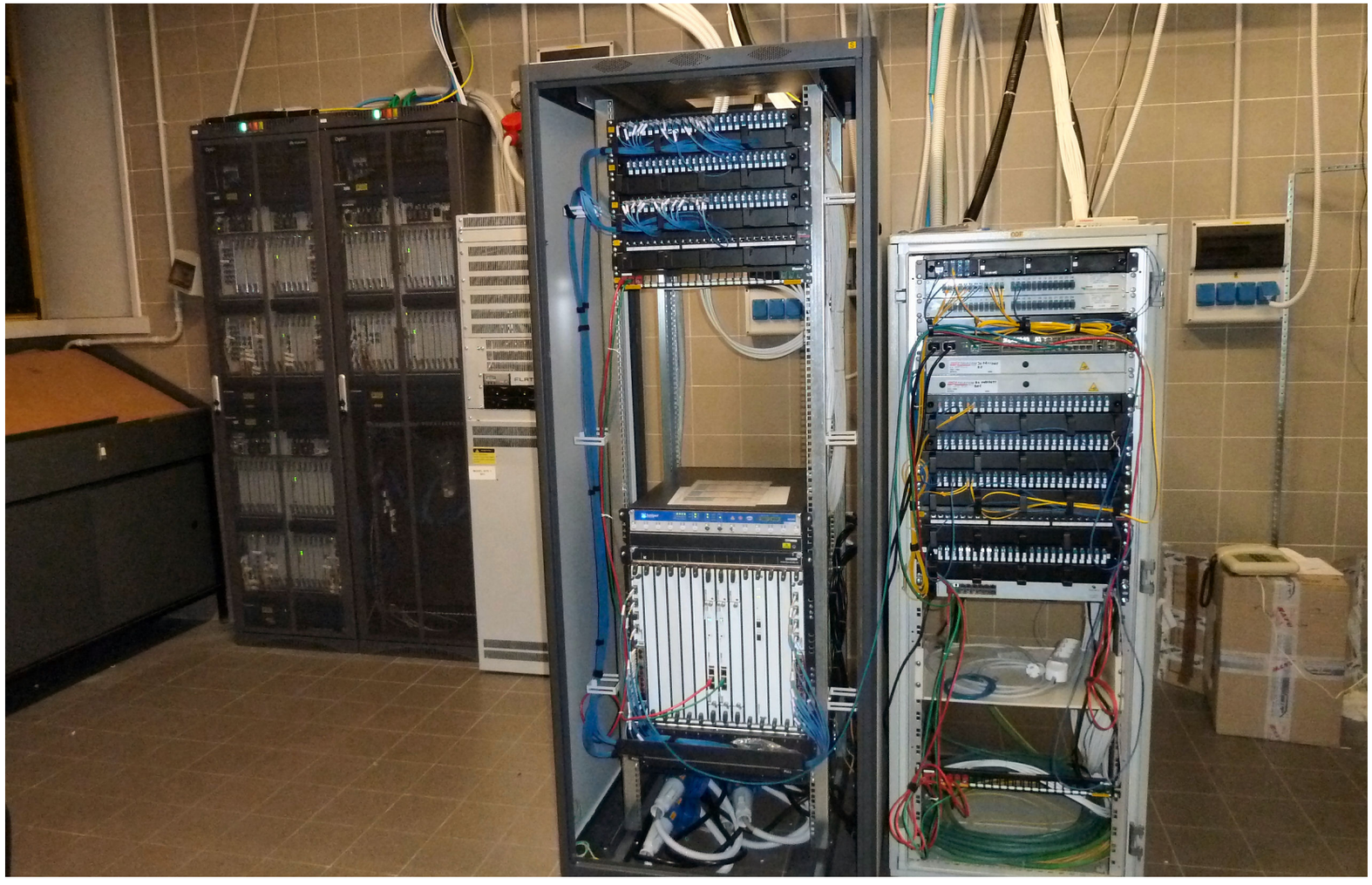
64 mt diameter antenna
Active surface
0.3 -- 100Ghz
high tracking speed

| cm | GHz | Resolutive power (arcsec) | | | |
|---|---|---|---|---|---|
| | | Medicina | Noto | SRT | VLBI - IT |
| 18 | 1,6 | 1474 | 1474 | 731 | 0,02 |
| 6 | 5 | 472 | 472 | 234 | 0,007 |
| 5 | 9 | 262 | 262 | 130 | 0,004 |
| 2.4 | 13 | 181 | 181 | 90 | 0,003 |
| 1.3 | 23 | 103 | 103 | 51 | 0,002 |

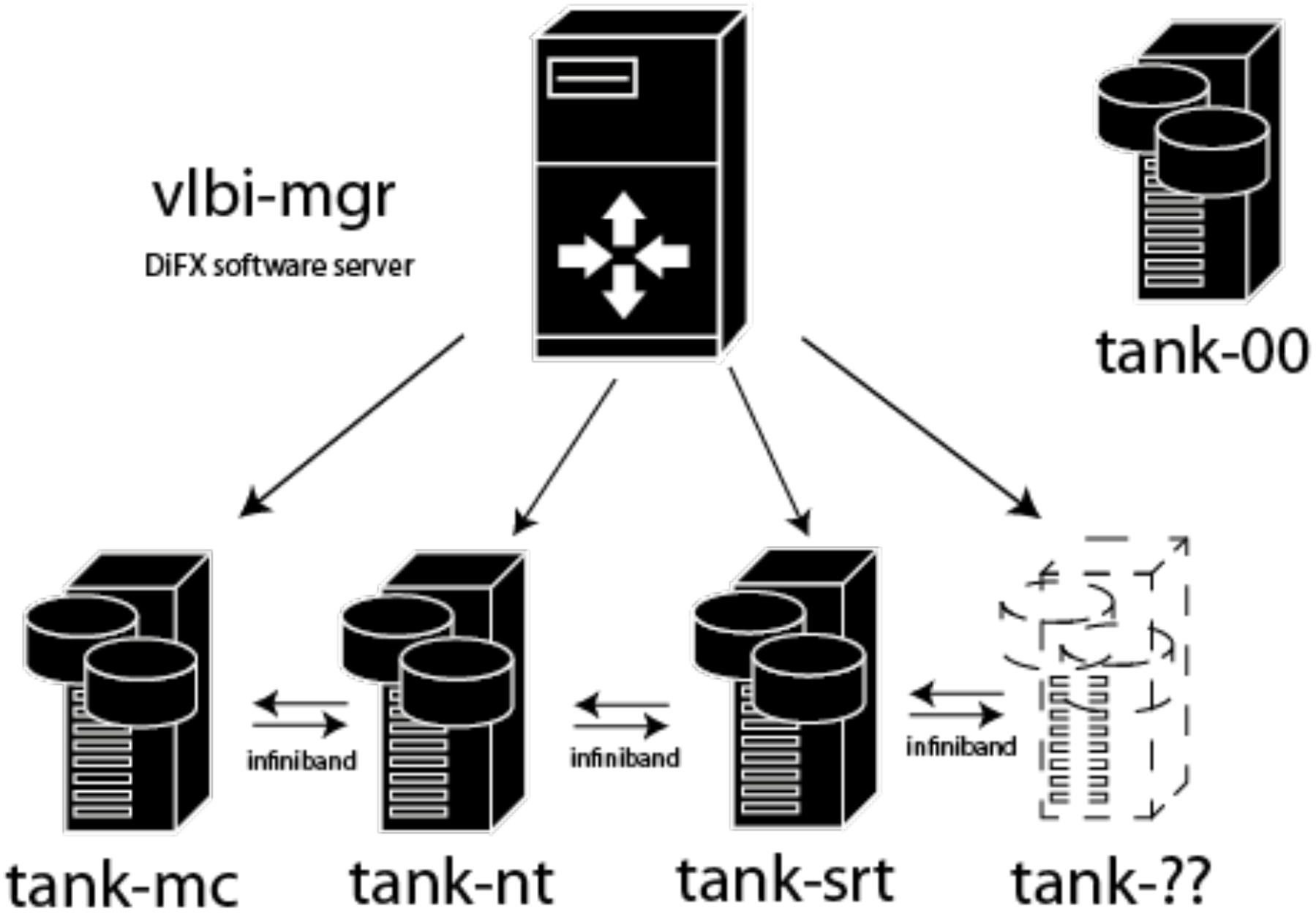
| | Antenna | Now | 2015 | 2016 |
|---|---|---|---|---|
|  | Mc - 32 mt | 10 Gbit/s | 10 Gbit/s | 10 Gbit/s |
|  | Nt - 32 mt | 10 Gbit/s | 10 Gbit/s | 10 Gbit/s |
|  | SRT - 64 mt | - | - | 10 Gbit/s (**?**) |
|  | IRA - HQ | 3 x<br>10 Gbit/s | 3 x<br>10 Gbit/s | 3 x 10 Gbit/s |

| | |
|---|---|
| Garr -> Geant now 2 x 40 Gbit/s | Band on Demand to EVN |



Juniper POP and Huawei Lambda DWDM devices




# Cluster Architecture

A dedicated storage node for each antenna

# Cluster view

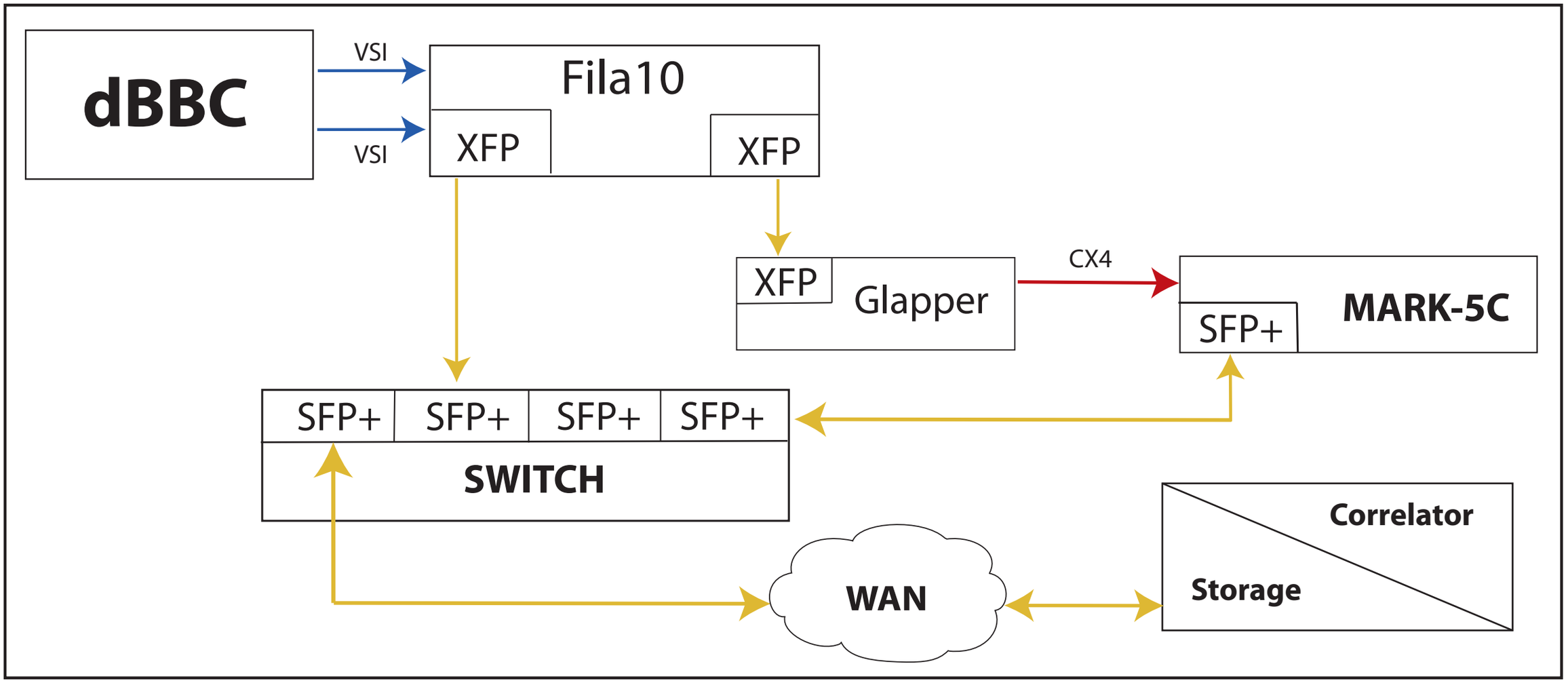
Infiniband connection

10 Gbit network

24 disks bay

Now 150 TB available

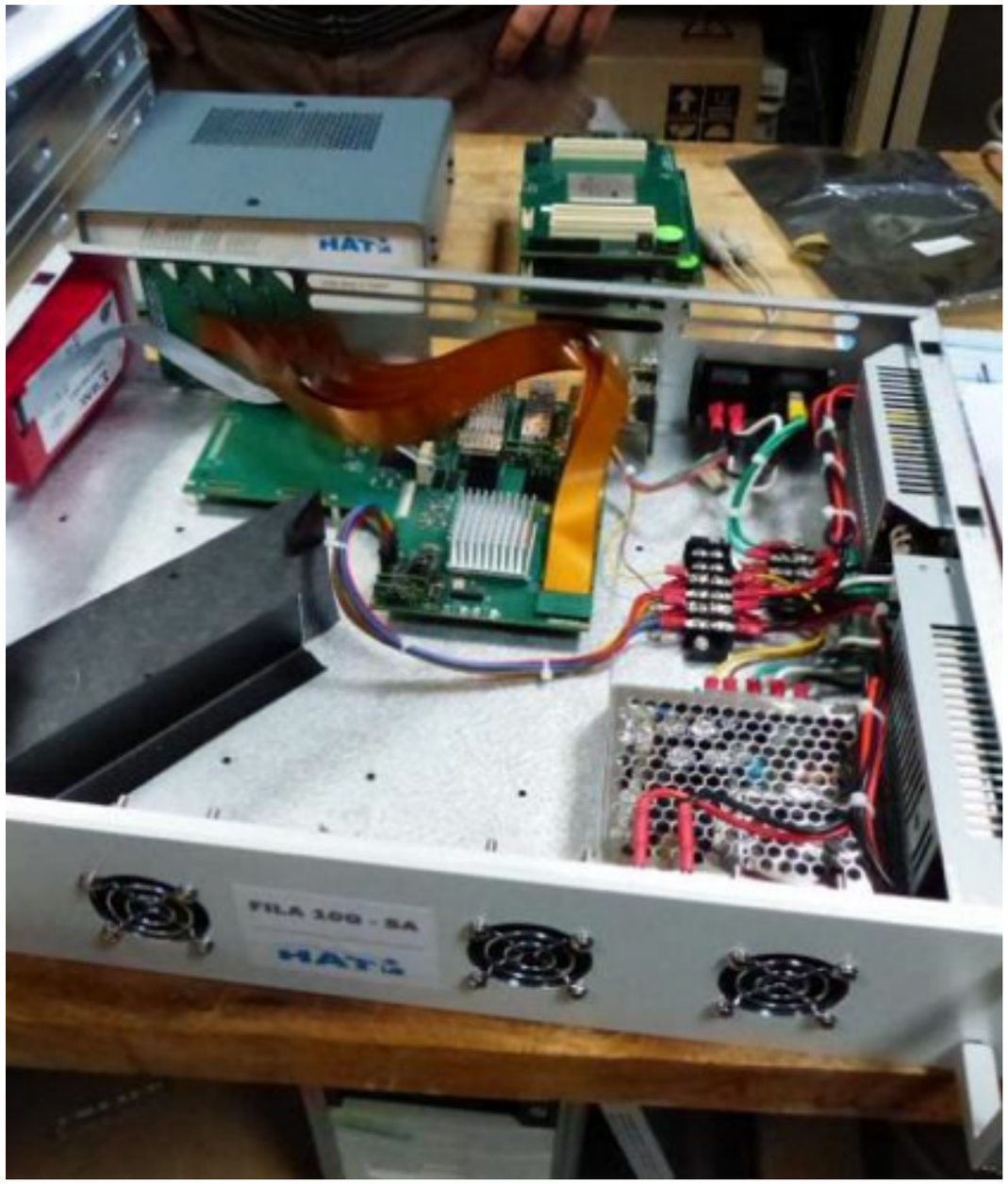
(20 TB SATA + 30 TB SAS each)




Network layout at stations

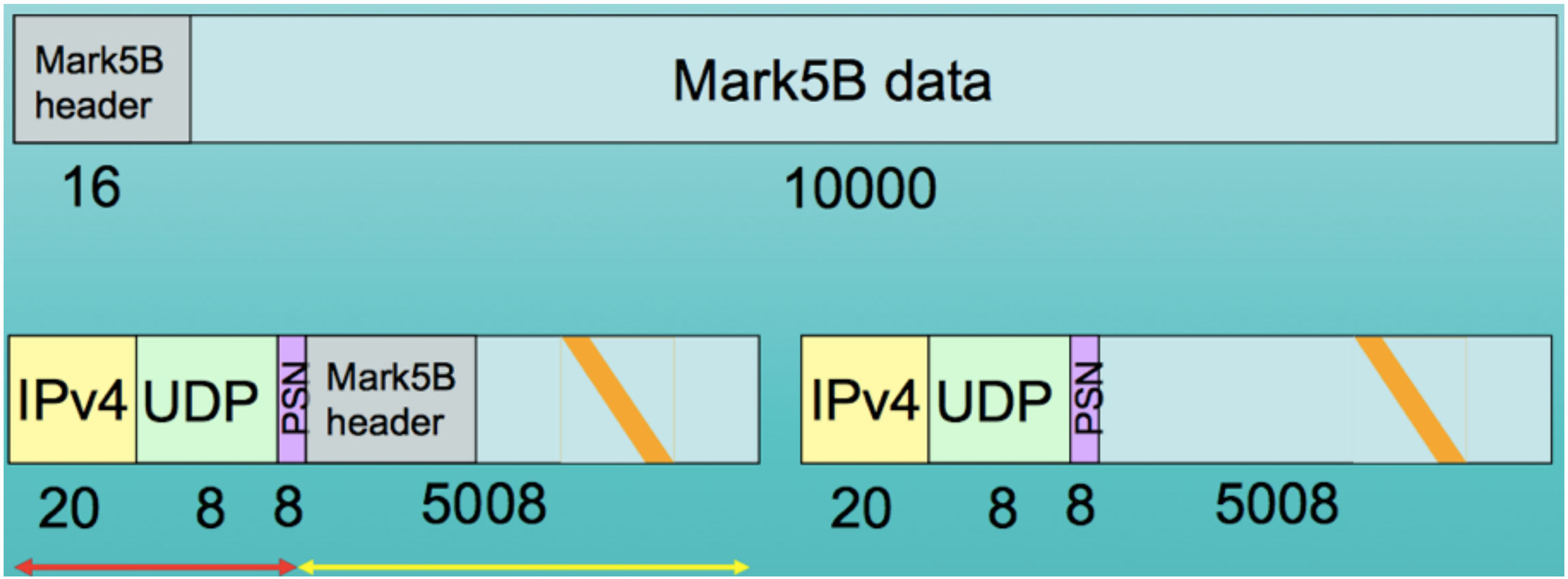
# Fila 10 G

- The Fila board (**Fi**rst - **La**st) is connected to the dBBC backend through a VSI cable and transfers the data onto an optical fiber adding a Mark5B or VDIF header acting as a formatter



# Mark5B data format

Data in Mark5B format has some network problems …




**Jive5ab** solves the problem by reassembling packets …

# 1 hr recording test @ 4 Gbit Medicina -> Bologna

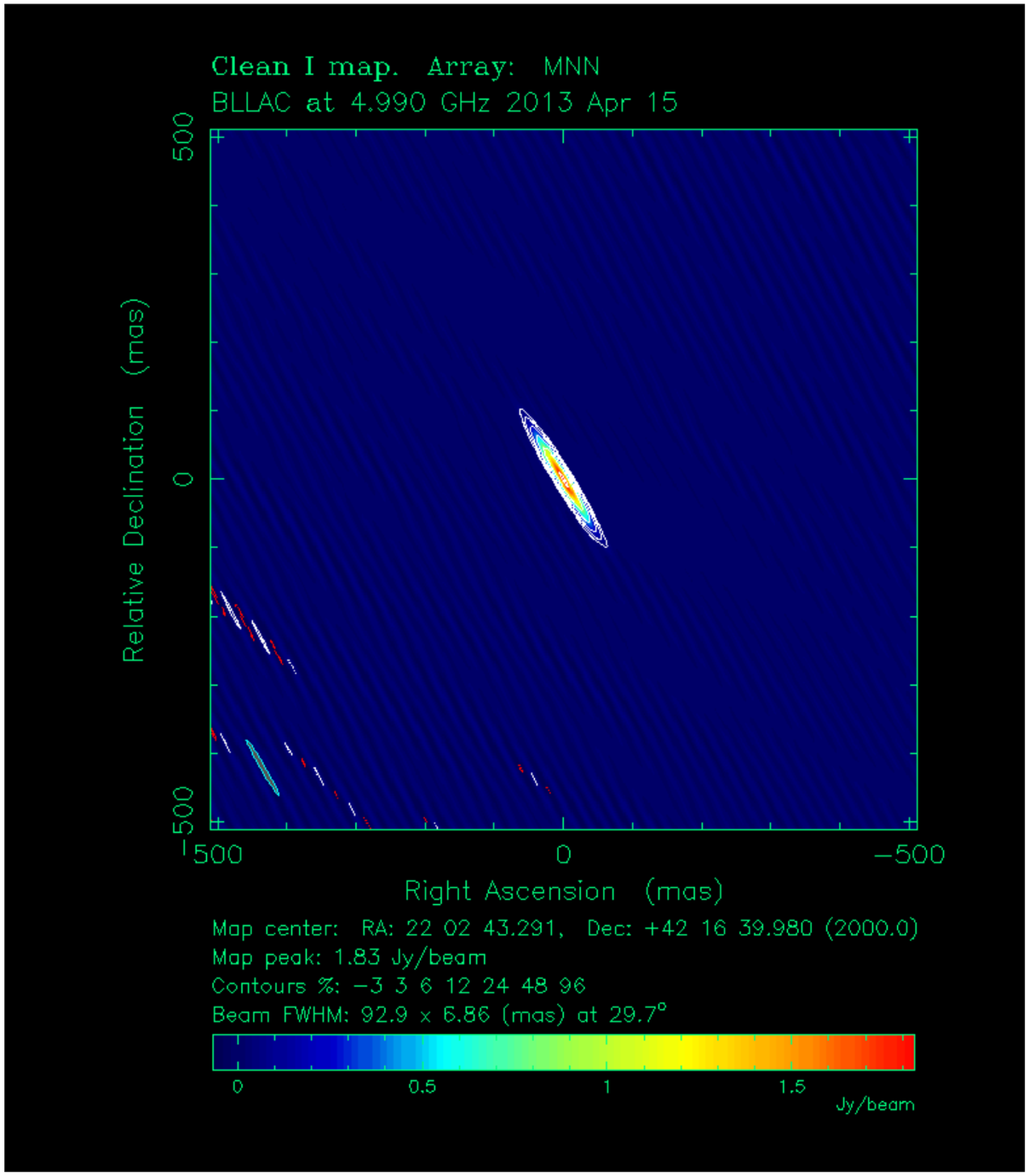
| 5008 bytes Mark5B - Fila 10 G split packets | SATA RAID 20 TB | SAS RAID 30 TB |
|---|---|---|
| **Lost packets** | 5102688 | 56782 |
| **Total packets** | 363651840 | 369577856 |
| **% lost** | **1.4 %** | **0.01 %** |

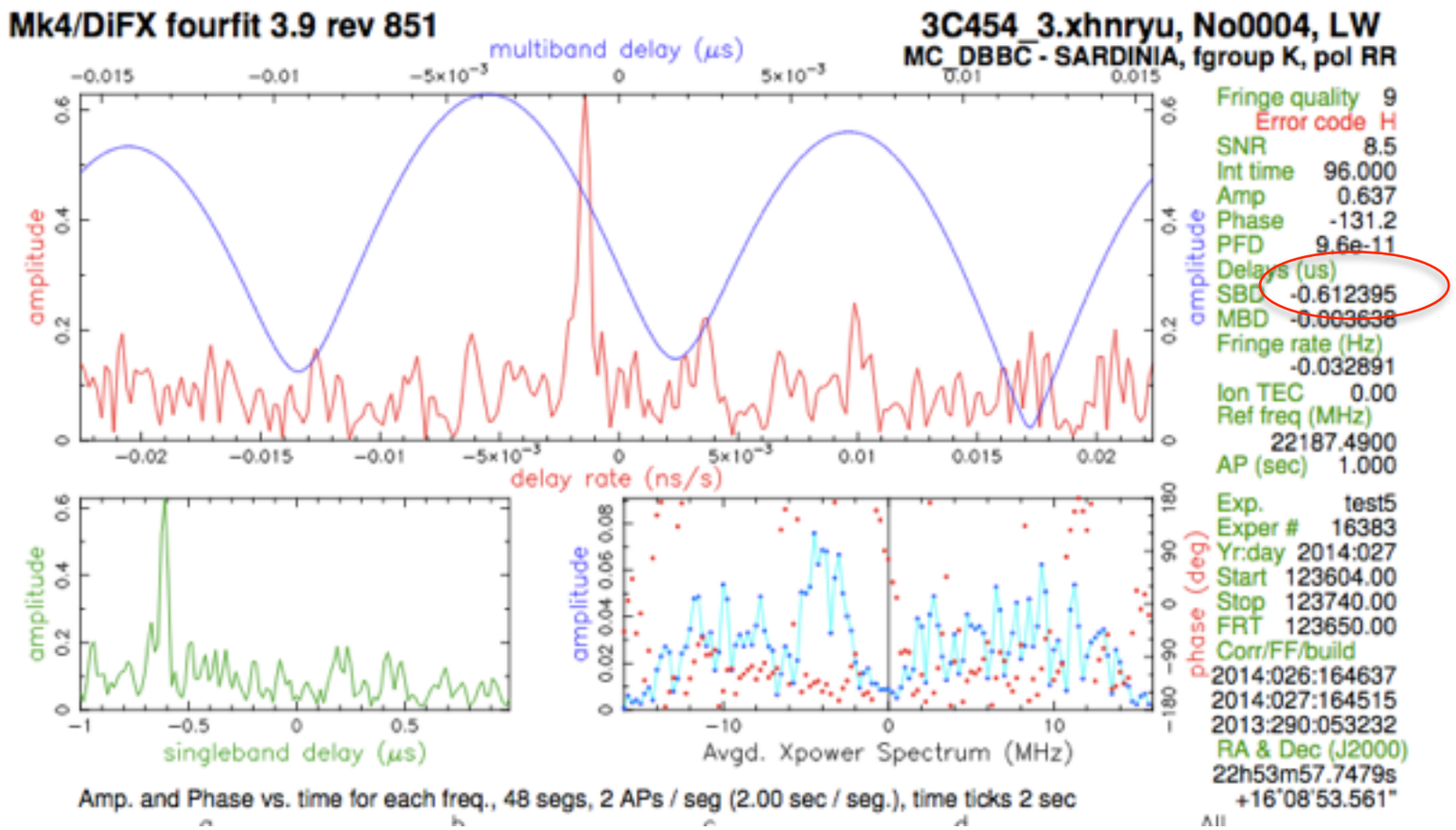
Thanks to Harro Verkouter's **jive5ab**

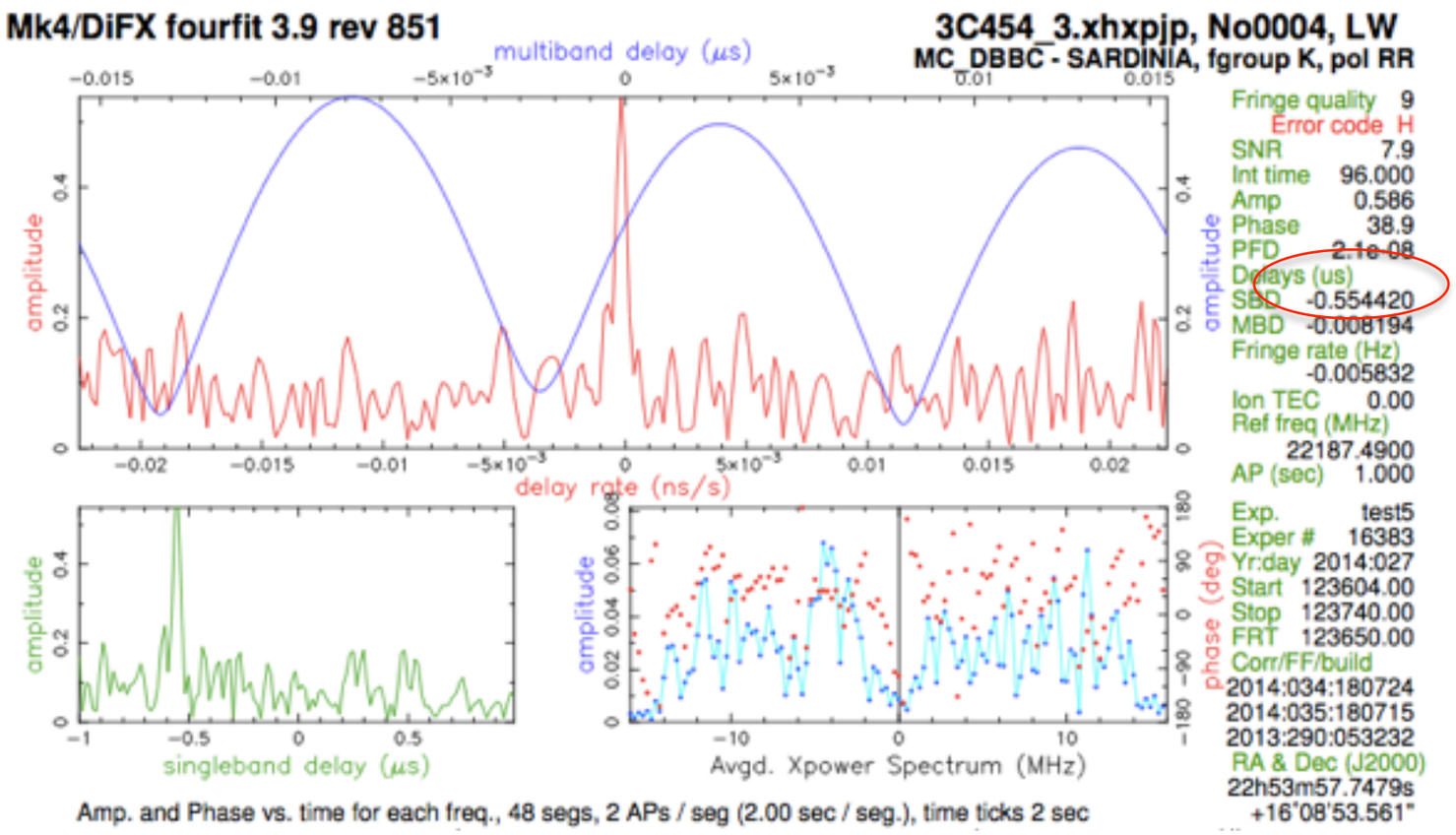
| Name | Band | Date | Result | Rec Speed | Mc | Md | Nt | Nd | SRT | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| 3C84 | L | 15/3/2013 | **NO** | 512 | X | | X | X | | Fringes Nt-Nd |
| ITVLBI | L | 17/3/2013 | **NO** | 512 | X | | X | | | |
| apr-15 | C | **16/4/2013** | **OK** | 512 | X | | X | X | | **First Fringes Mc - Nt** |
| ivlbi | X | 12/10/2013 | **NO** | 512 | X | X | | X | X | Fringes on few scans Mc-Md-Nd |
| nov25 | K | 28/11/2013 | **NO** | 1024 | | X | | X | | Clock problems Md |
| dec5 | X | 7/12/2013 | **NO** | 1024 | | X | | | X | Clock problems Md-SRT |
| dec17 | L | 17/12/2013 | **NO** | 1024 | | X | | X | | Clock problems Md |
| ivlbi | X | 3/1/2014 | **OK** | 512 | X | X | | | | |
| temp2 | L | **13/1/2014** | **OK** | 1024 | | X | | X | | Fringes Md-Nd-Hh / **Nd + 1sec** |
| test5 | K | **27/1/2014** | **OK** | 1024 | | X | | | X | **First Fringes SRT** |
| test5 | K | **4/2/2014** | **OK** | 1024 | | X | | | X | **New position SRT** |
| l128 | L | 18/2/2014 | **OK** | 128 | | X | | | X | |
| l1024 | L | 19/2/2014 | **NO** | 1024 | | | | | X | Clock problems Md-SRT |
| l512 | L | 19/2/2014 | **NO** | 512 | | X | | | X | Clock problems Md-SRT |
| test10 | X | 28/2/2014 | **NO** | 512 | | X | | | X | No fringes SRT |
| r4620 | S/X | **19/3/2014** | **OK** | 512 | X | X | | | | Strong Fringes CTA26<br>**streaming from Md to Bologna** |
| 1313 | C | 28/3/2014 | **OK** | 512 | X | X | | X | | Australian campaign |
| ap30b | C | 30/4/2014 | **NO** | 1024 | | | | X | X | Autocorrelation Nd-Nd streaming<br>only p_cal |
| 3c161 | C | 15/5/2014 | **OK** | 512 | X | X | | X | | Test on 3c161 |
| taurusa | X | **15/5/2014** | **OK** | 1024 | X | X | | | | Transient test **Md streaming to Bologna** |
| may23 | L | 23/5/2014 | **NO** | 512 | X | X | | | X | Mc-Md streaming only p_cal |

# First test

- Medicina - Noto baseline
- 15-04-2013






SRT position measured more accurately after the first fringe

Delay reduced by 0.1 μsec

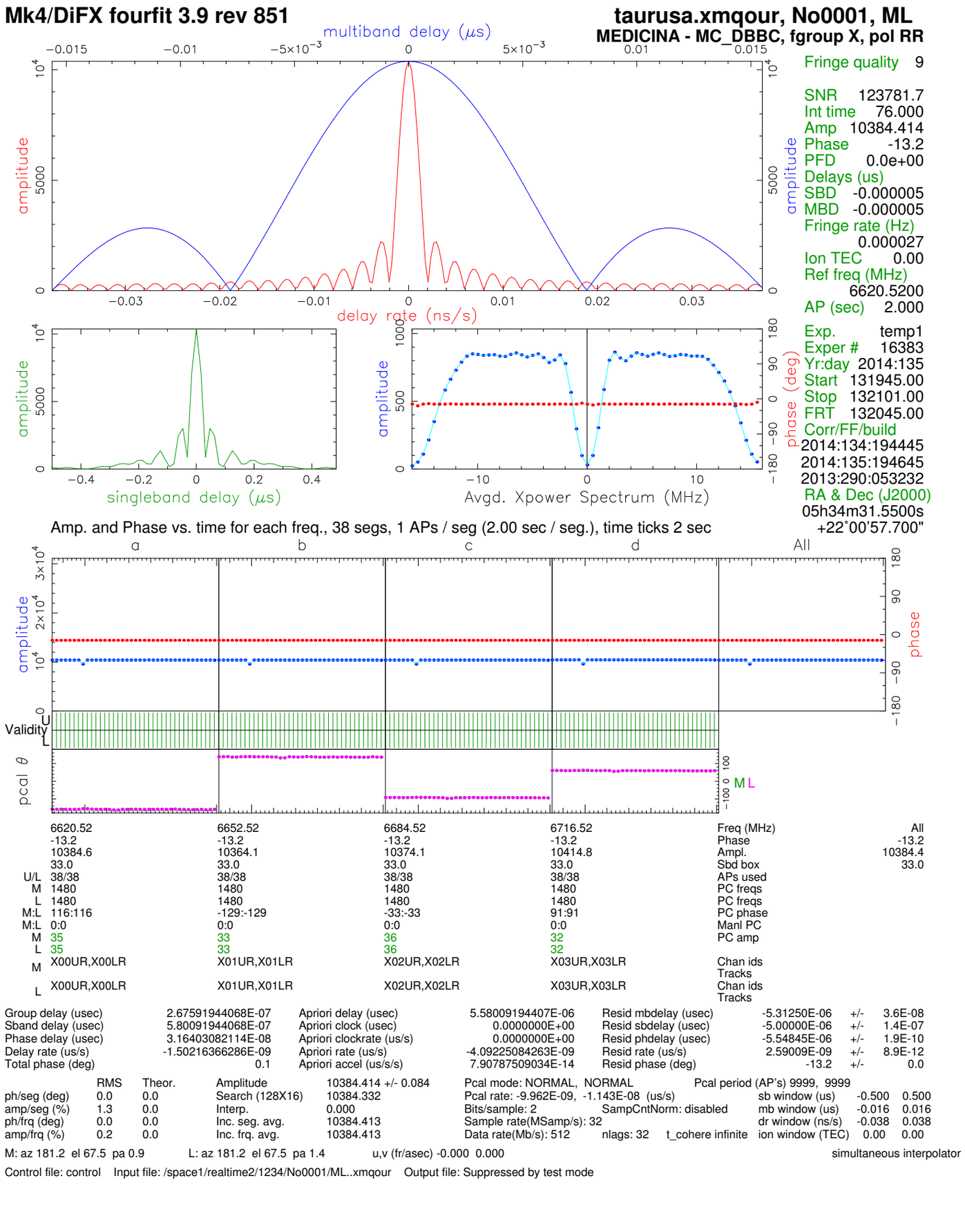
✓

Weather problems in Sardinia

✗

# Medicina dBBC streaming to Bologna @ 1 Gbit while recoding with Mark5C at the station

Taurus A passing over a **stopped** antenna…



# Mark5B header

SYNCWORD + FRAME # + MJD (3) + SEC FROM 00:00 + µSEC

**Fila 10 G formatter**

```
ABADDEED *    0  81259812 00000000
ABADDEED *    1  81259812 00000000
ABADDEED *    2  81259812 00000000
ABADDEED *    3  81259812 00000000
ABADDEED *    4  81259812 00000000
ABADDEED *    5  81259812 00000000
ABADDEED *    6  81259812 00000000
ABADDEED *    7  81259812 00000000
ABADDEED *    8  81259812 00000000
ABADDEED *    9  81259812 00000000
```

**Mark5B+ formatter**

```
ABADDEED      0  81259773 00005CD6
ABADDEED      1  81259773 00035CDC
ABADDEED      2  81259773 00065CC2
ABADDEED      3  81259773 00095CE0
ABADDEED      4  81259773 00125CBA
ABADDEED      5  81259773 0015DCAB
ABADDEED      6  81259773 00185C86
ABADDEED      7  81259773 00215C10
ABADDEED      8  81259773 0025DC0B
ABADDEED      9  81259773 00285C26
```

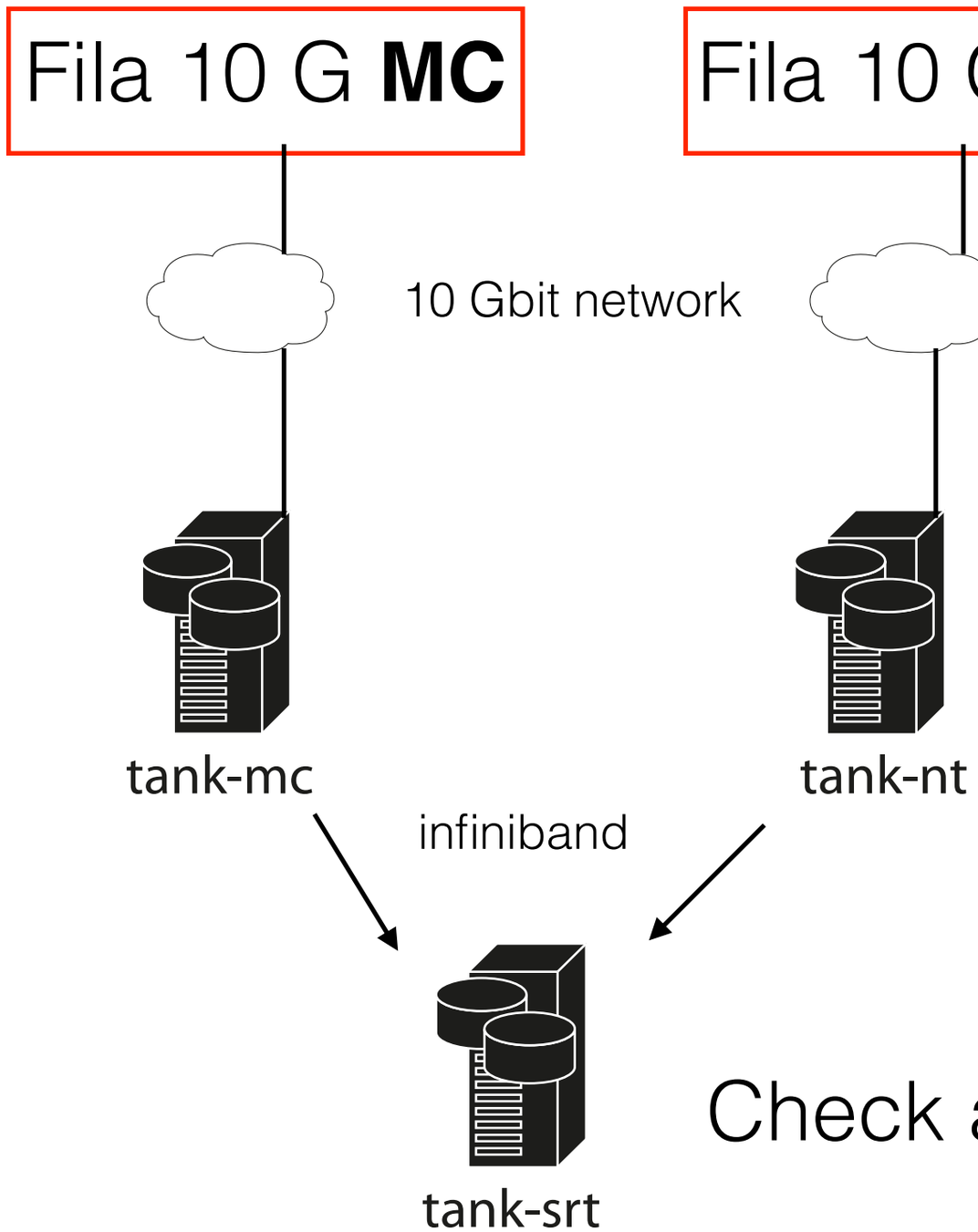
# TIMESYNC

- Fila 10 G fromatter needs manual timesync command from operator to sync to PPS coming from dBBC VSI cable
- Issues about when to press the enter button
- How to track time slips without μsec in headers?

# vlbiTimeServer

- Analyze data headers in real time coming from the antenna
- Quicker than organizing a proper observation
- No need to record any data
- Can run when antennas are down (maintenance)

# vlbiTimeServer




- Stripping header from data
- Get first frame of the second
- Send to analyzing machine

Check arrival time of packet (UNIX µSEC)

# vlbiTimeServer

- Network delay -> 0.10 **seconds** between Noto and Medicina
- Packets lost - sometimes
- Run continuously over a week @ 1 Gbit and no time slips
- When time slips need to re-sync dBBC FPGA and Fila 10

# VDIF

| | Bit 31 (MSB) | | | Bit 0 (LSB) |
|---|---|---|---|---|
| | Byte 3 | Byte 2 | Byte 1 | Byte 0 |
| Word 0 | $I_1$ | $L_1$ | Seconds from reference epoch$_{30}$ | |
| Word 1 | Un-assigned$_2$ | Ref Epoch$_6$ | Data Frame # within second$_{24}$ | |
| Word 2 | $V_3$ | $\log_2$(#chns)$_5$ | Data Frame length (units of 8 bytes)$_{24}$ | |
| Word 3 | $C_1$ | bits/sample-1$_5$ | Thread ID$_{10}$ | Station ID$_{16}$ |
| Word 4 | EDV$_8$ | | Extended User Data$_{24}$ | |
| Word 5 | Extended User Data$_{32}$ | | | |
| Word 6 | Extended User Data$_{32}$ | | | |
| Word 7 | Extended User Data$_{32}$ | | | |

# VDIF

**Why NOT ATM?**

- Fila 10 G firmware unreliable (switch from big to little endian - compulsory change of thread number at certain sampling speed)
- *Sched* not producing VDIF in VEX files - hand edit
- Station operators not confident enough - new dBBC backends

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# Questions?

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